Space Weather Technical Forecast

Issued on Tuesday, 19 September 2023 at 13:10 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Further G1-G2 minor/moderate storms possible day 1 (Tuesday 19th September), with CME effects. Chance of isolated R1 Minor Radio Blackouts throughout.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity is Moderate over the past 24 hours, with an M1.8 flare observed peaking at 19/0938 UTC. Another M-class flare was observed around 19/0400UTC There are currently eight numbered sunspot regions on the visible disc. The previously active AR3429 has continued to see a general weakening with both AR3436 and AR3437 continuing to develop in the western hemisphere. The largest region on the disk remains AR3435 in the east, this region has seen its previous leading spot re-numbered as AR3438, which is now growing a ringlet around it, so one to watch (ringlets are known to destabilise the local magnetic structure).
No new Earth-directed CMEs were observed in available imagery.

Solar Wind / Geomagnetic Activity: Solar winds, as measured by DSCOVR/ACE at L1, were at slightly elevated levels initially, before rapidly increasing from 18/1255 UTC with the arrival of a CME, with speeds becoming elevated and varying between 500-600km/s through the remainder of the period. The solar wind density was at generally average levels throughout, with a slight increase associated with the arrival of the CME. The IMF was steady at moderate levels of 8-10nT, with a rapid increase to a peak of around 21nT following the arrival of the CME and a slow decline back towards moderate levels in recent hours. The north-south component showed a similar trend varying between +6/-7nT initially, becoming moderately positive with the arrival of the CME, before varying strongly between +17/-18 for a few hours after the impact. The phi angle was predominantly negative (toward the Sun), before turning more variable after 19/0000 UTC. Geomagnetic activity, as measured by BGS, was at Active to G1 Minor geomagnetic storm with the arrival of the CME, and peaked at G3 Strong geomagnetic storm in the 19/0300-0600 UTC interval.

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux was slightly increased, with an early period peak around 2 pfu, before a slow reduction back towards Background levels. GOES16 high energy (greater than 2MeV) electron flux was at Normal Background to Moderate levels. The associated 24-hour fluence was well below the Active threshold, with 7.86e6 integrated pfu observed at 19/0001UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to remain generally Low with a continued chance of isolated M-class flares, perhaps most likely in the short term from AR3436 or AR3437.

Solar Wind / Geomagnetic Activity: There are currently two CMEs that feature in the forecast. The first CME is likely associated with an M2.4 flare from AR3229 at 14/2126UTC. This feature may be the CME affecting the near Earth environment in the past 24 hours. There is some

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uncertainty however with a second and perhaps more significant CME, from a large filament lift off which occurred early on the UTC day of 16 Sep. Modelling suggests an Earth directed component with an arrival time sometime during Day 1 (19 Sep). Analysis of both these features was complex however, reducing forecast confidence, and it may be that the CME currently affecting Earth may be associated with an early arrival of the second CME. Either way CME effects are expected to continue through Day 1 (19 Sep), before easing into Day 2 (20 Sep). Unsettled to Active geomagnetic activity at first, with a Chance of a G2 moderate storm due to the potential arrival of further CME activity associated with the filament eruption on 16 Sep. CME effects probably lingering into Day 2 (20 Sep) but likely waning by Days 3-4 (21-22 Sep), with generally Quiet to Unsettled conditions returning.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux is expected to remain at Background levels, with a daily slight chance of an enhancement should any larger flares occur, or perhaps early in the period in association with CME arrival.
High energy (greater than 2 MeV) electron flux is likely to be suppressed at Normal Background levels at GEO through much of the period, but with reducing confidence. Overall, the 24-hour fluence is expected to remain below the Active threshold throughout the period, with reducing confidence later in the period.

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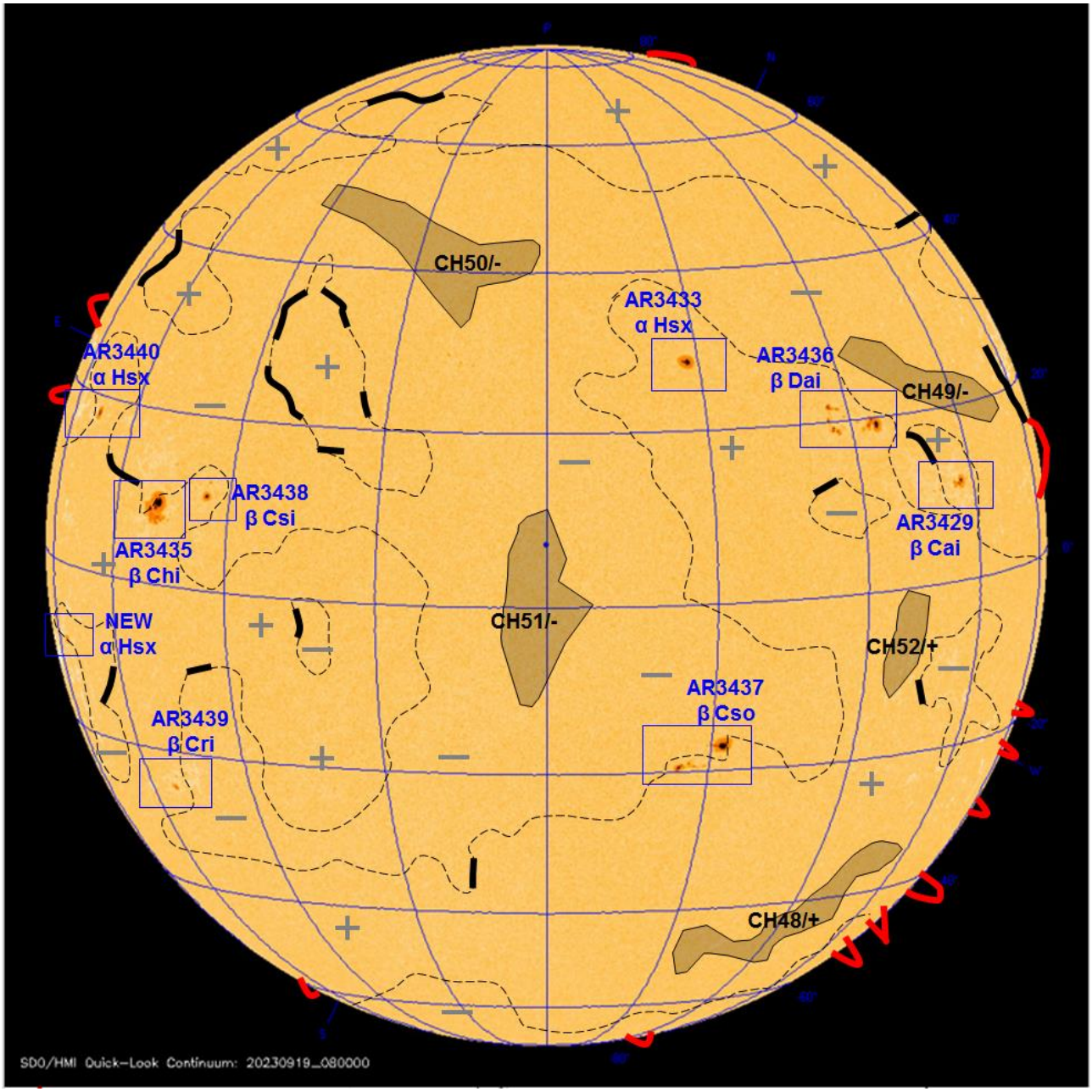
Figure 1. Solar Analysis Valid 0800UTC, 19 September 2023.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There are currently two ongoing CMEs that feature in the forecast.

The first CME is likely associated with an M2.4 flare from AR3229 at 14/2126UTC. This feature may be the CME currently moving through the near Earth environment. There is some uncertainty however with a second and perhaps more significant CME from a large filament lift off which occurred early on the UTC day of 16 Sep. This CME produced an asymmetric halo seen clearly in LASCO-C2 and C3 coronagraph imagery with the bulk of the material heading to the south and west. Modelling suggests an Earth directed component with an arrival time sometime during Day 1 (19 Sep). Analysis of both these features was complex however, reducing forecast confidence and it may be that the CME currently affecting Earth may be associated with an early arrival of the second CME. Either way CME effects are expected to continue through Day 1 (19 Sep), before easing into Day 2 (20 Sep).
Coronal Hole HSS influence has lower than average forecast confidence through the period, complicated by the potential influence from one or more coronal holes. With CH49/- in the northwest or perhaps the increasingly fading CH52/+ having a potential influence from Day 2 onwards.
CME effects are expected to continue through Day 1 (19 Sep), before easing into Day 2 (20 Sep). Unsettled to Active geomagnetic activity at first, with a Chance of a G2 moderate storm due to the potential arrival of further CME activity associated with the filament eruption on 16 Sep. CME effects probably lingering into Day 2 (20 Sep) but likely waning by Days 3-4 (21-22 Sep), with generally Quiet to Unsettled conditions returning.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	60	40	10	1
Strong	G3	No	20	5	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
16/0800-1000	Full	Filamenr eruption	Centre disc	635 km/s	19/1200 UTC	Low confidence

Figure 2: Latest 24hr L1 Magnetometer trace showing clear CME arrival yesterday.

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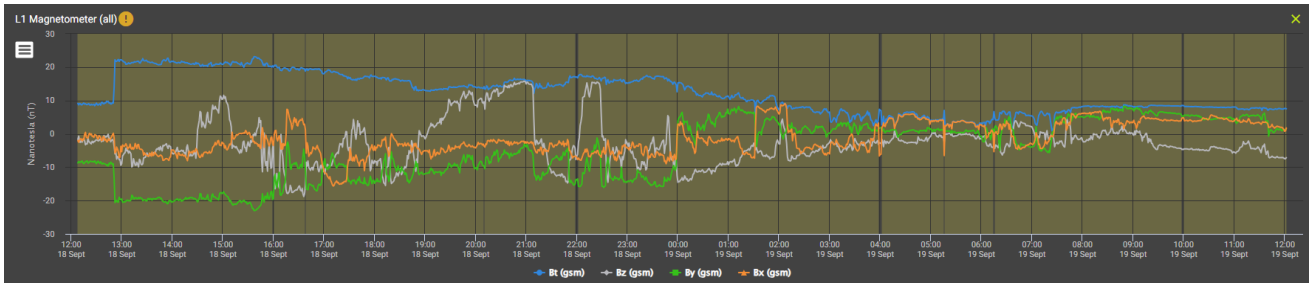
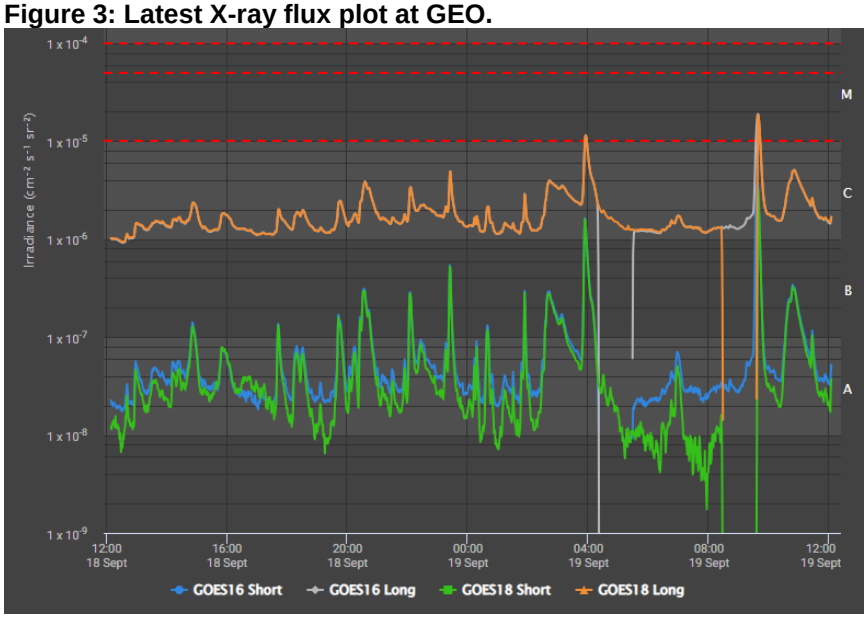


Radio Blackouts - X-Ray Flares:

The previously active AR3429 has continued to see a general weakening trend though some low level flaring persists. Both the recently developed AR3436 and AR3437 have shown signs of growth and are rapidly becoming the focus for potential activity in the western hemisphere. The largest region on the disk remains AR3435 in the east, and this region has seen its previous leading spot re-numbered as AR3438, which is now growing a ringlet around it, so one to watch (ringlets are known to destabilise the local magnetic structure).
Solar activity is expected to remain generally Low, but with a continued chance of isolated M-class flares, perhaps most likely in the short term from AR3436 or AR3437.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	30	30	30	30
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 3: Latest X-ray flux plot at GEO.



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Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux observed by GOES16 is expected to persist at Background levels, but with a daily slight chance of flux levels rising in response to any significant flaring, or perhaps early in the period in association with CME arrival.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

High energy (greater than 2MeV) electron flux levels are currently at Background levels. An uncertain forecast, with geomagnetic activity associated with recent and potential CMEs early in the forecast period likely to impede any prolonged rise initially. CME arrivals and continued elevated solar winds have likely seen a build up of change within the belts and any easing of solar winds and reduction of geomagnetic activity will likely see flux levels rise quickly.
The 24-hour fluence is currently below the Active threshold, with current MOSWOC REFM model output likely providing reasonable guidance at least initially. Forecast is lower confidence however given uncertainties above, with an increasing risk of breaching the active threshold into the period.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	5	10	20	30
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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